US Army Corps of Engineers Detroit District

Great Lakes Update

Volume 192: 2014 Annual Summary

Background

The U.S. Army Corps of Engineers (USACE) tracks and forecasts the water levels of each of the Great Lakes. This report is primarily focused on summarizing the hydrologic conditions of the Great Lakes basin in 2014.

Following a long period of much lower than average water levels, especially for Lakes Superior and Michigan-Huron, levels began to recover during 2013 and even surpassed long term average water levels in 2014. At the beginning of 2015, all of the Great Lakes are at a higher level than at the beginning of 2014, with the exception of Lake Ontario. A summary of 2014 Great Lakes water levels is discussed below in the lake-by-lake sections.

Official water levels are based on monthly lake-wide means, and the period of record used for each of the lakes includes the years 1918 to 2013. These data have been coordinated between the United States and Canada. All 2014 water levels will be officially coordinated and added to the historical record in the spring of 2015. The elevations used are referenced to the 1985 International Great Lakes Datum. The water level of each lake is averaged from a network of individual gages around each lake. Also of note is that Lake Michigan and Lake Huron are hydraulically treated as one lake due to their connection at the Straits of Mackinac.

The Great Lakes are very large and behave differently from smaller, inland lakes. In general, Great Lakes water levels do not rise and fall with individual storms, but rather significant water level fluctuations require multiple months, seasons, or years of wet or dry conditions.

Seasonal changes in weather patterns typically cause an annual pattern of rising and falling of Great Lakes water levels. Each of the Great Lakes typically exhibits a seasonal rise in the spring primarily caused by an increase in precipitation, increased runoff due to melting of accumulated snow, and low evaporation rates. The typical seasonal decline of the water levels in the fall and winter is primarily caused by an increase in evaporation, a decrease in precipitation, and the accumulation of snowpack on the land area.

The Net Basin Supply (NBS) is an important quantity for understanding the amount of water which arrives to the lake. USACE uses the residual method to compute NBS, shown below:

Residual Method Net Basin Supply:

$$NBS = WL - I - D + O$$

WL: Water Level Change
I: Connecting Channel Inflow
O: Connecting Channel Outflow
D: Diversion into(+) or out(-) of lake

Altogether, NBS represents the combined effects of precipitation, runoff, and evaporation. NBS is far and away the main driver of water levels, and is also discussed in more detail in the following sections for each lake.

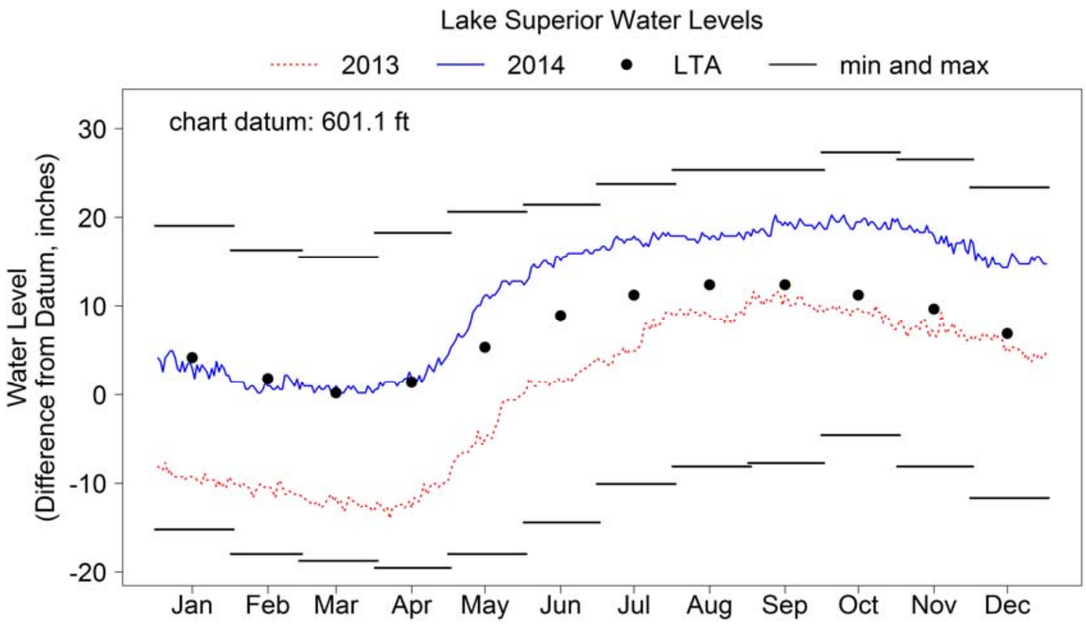

Figure 1: Lake Superior Water Levels

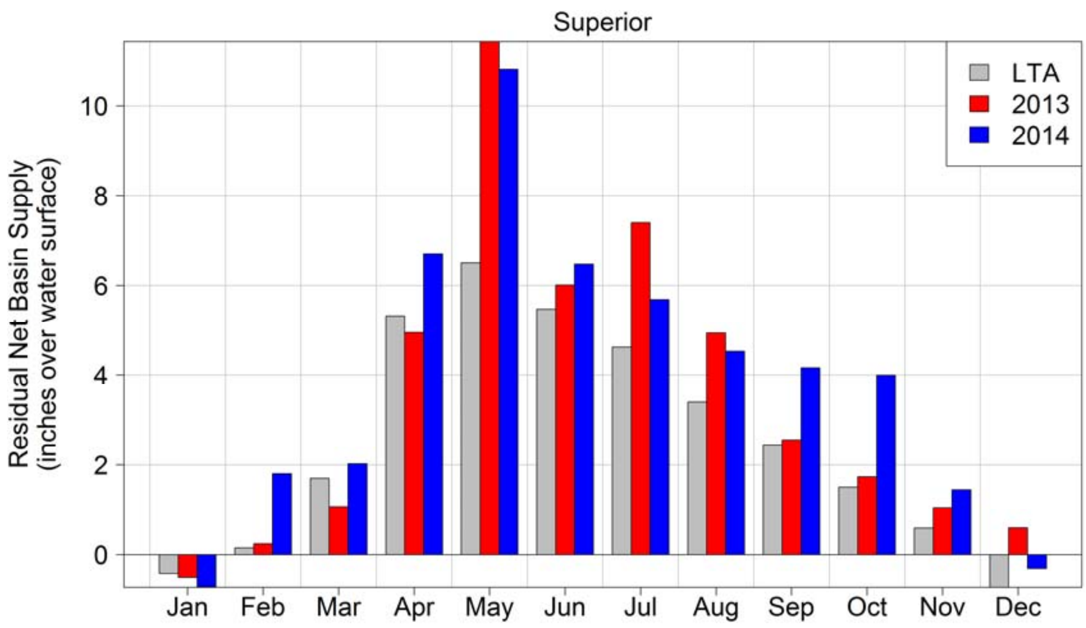

Figure 2: Lake Superior Residual Net Basin Supply

Lake Superior

Figure 1 shows the 2014 water levels of Lake Superior compared with the 2013 levels and the monthly long-term average (LTA) levels. A similar figure is shown for each lake in the following sections. Each lake's data has been plotted relative to chart datum (a.k.a. low water datum), which represents the horizontal line at a value of zero. Chart datum for Lake Superior is

601.1 ft. The solid line in Figure 1 represents the 2014 water levels and the dotted line shows the 2013 levels. The LTA levels for each month are shown by the solid circles.

By September of 2013, Lake Superior water levels had recovered to only 2 inches below LTA levels. This followed a nearly continuous period of low water levels that began in 1998. This recovery was largely due to a dramatic March to September rise of 23 inches (normal seasonal rise is 12 inches). A similarly dramatic rise occurred in 2014, when Lake Superior rose nearly 19 inches from March to October. The seasonal rises of 2013 and 2014 were the second and tenth largest rises recorded from 1918 to 2014, respectively. As a result, Lake Superior levels have been above LTA levels since March of 2014, and the January 2015 monthly mean water level was 9 inches above its LTA (10 inches higher than January 2014).

The large seasonal rises during 2013 and 2014 were caused by higher than average net basin supply (NBS), which incorporates the net effect of precipitation, runoff, and evaporation. Figure 2 shows the Lake Superior NBS for each month in 2014 compared to both the 2013 NBS and the historical average NBS. Large NBS values during May of 2013 and May of 2014 correspond to rapid lake level rise. May of 2013 and 2014 ranked the second and third highest NBS in the period of record, which includes coordinated data from 1900 to 2008 and provisional data from 2009 to 2014 . Precipitation was almost 10% above average during 2014, with up to 56% above average precipitation during the month of June and 25% to 38% above average precipitation during the months of October and November. Additionally, the colder than average winter resulted in very high ice coverage as well as increased snowpack, with the snowpack translating to high spring runoff to Lake Superior. NBS was consistently higher than normal from May 2013 throughout 2014.

Lake Michigan-Huron

Following historic low water levels in late 2012 and early 2013, Lake Michigan-Huron had returned to near the low water datum by the end of 2013. By September 2014, water levels reached their long term average due to a 20 inch seasonal rise (average seasonal rise is 11 inches). Levels have remained above average since September, as shown in Figure 3. Water levels in Figure 3 are relative to the Lake Michigan-Huron chart datum level of 577.5 ft.

The 2014 seasonal rise for Michigan-Huron was 23 inches from January through November. Normally, the seasonal rise occurs from January through July. The 2014 seasonal rise ranked the fifth largest rise since 1918. Despite the dramatic rise of 2013 and 2014, Lake Michigan-Huron water levels in December were nearly 29 inches below their long term maximum December level.

Figure 4 shows the 2014 NBS for Lake Michigan-Huron compared to the 2013 NBS and the historical averages. The year began with lower than average NBS due to lower than average precipitation and increased storage of that precipitation in snowpack. However, the basin experienced very high NBS in April and May (ninth and eleventh highest in the period of 1900 to 2014) due to higher than average precipitation and runoff from melting snow. The higher than normal NBS during August to September are also responsible for the lack of seasonal decline in lake levels normally occurring during the late summer and autumn.

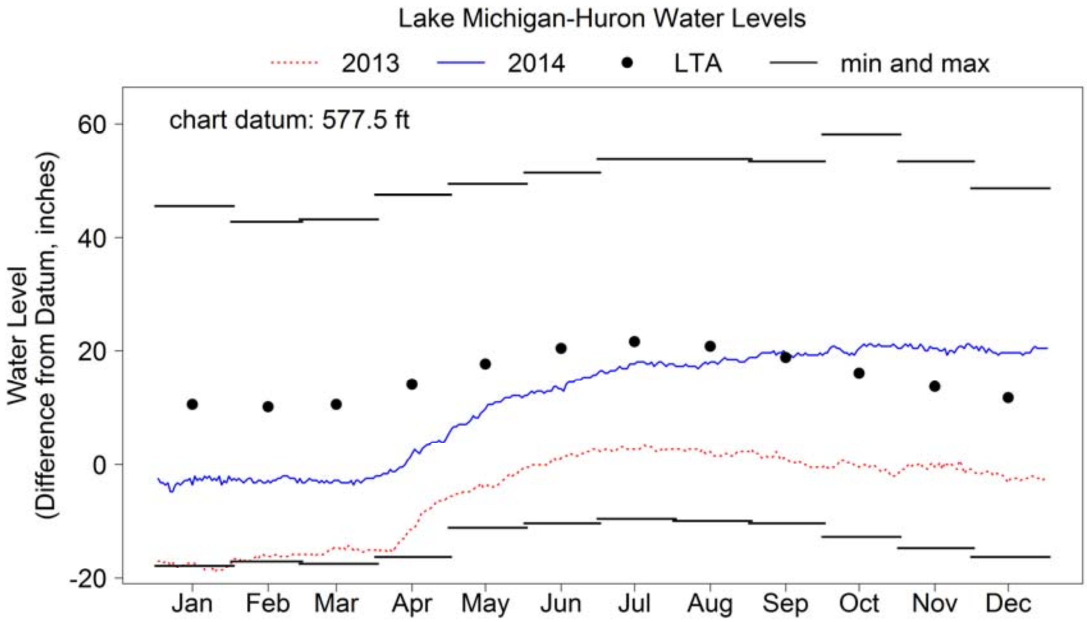

Figure 3: Lake Michigan-Huron Water Levels

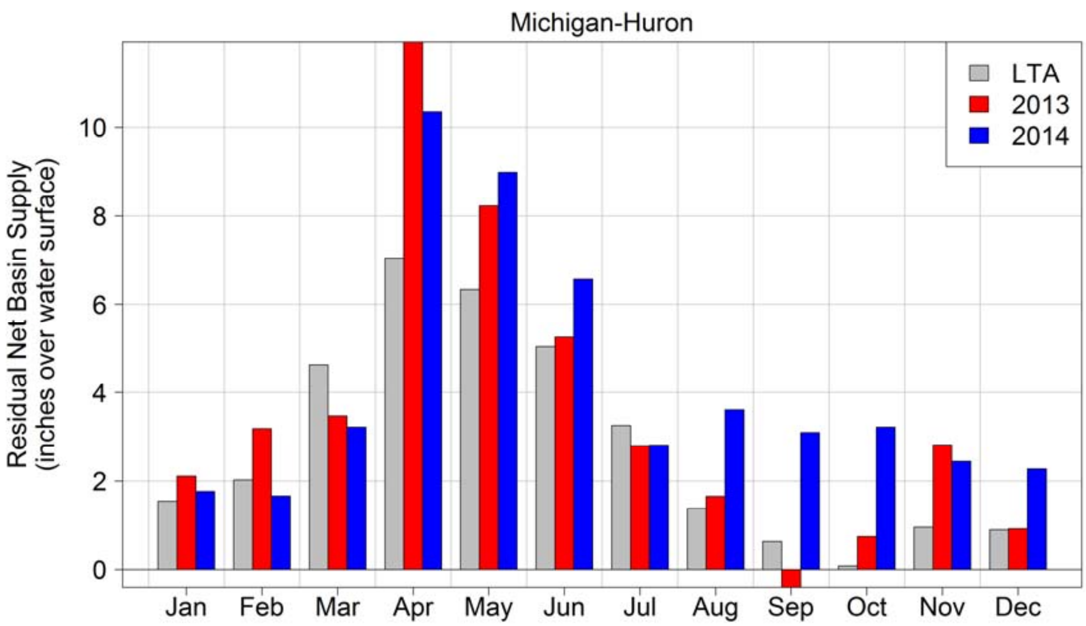

Figure 4: Lake Michigan-Huron Residual Net Basin Supply

Lake St. Clair

As seen in Figure 5 Lake St. Clair water levels exhibit more short-term fluctuation than lakes Superior, Michigan-Huron, Erie, or Ontario because of the smaller size of Lake St. Clair. The smaller size causes the connecting channels (the St. Clair River upstream and the Detroit River downstream) to have a large influence on the Lake St. Clair water levels. Wind, ice, and other climate variations can cause fluctuations in the hydraulic behavior through the St. Clair River, Lake St. Clair, and Detroit River system. The Lake St. Clair water level is starting 2015 much higher than 2014 due to the nearly 26 inch rise from February 2014 to August 2014 followed by only a 5 inch fall from September to December. Lake St. Clair water levels have been above average since June 2014.

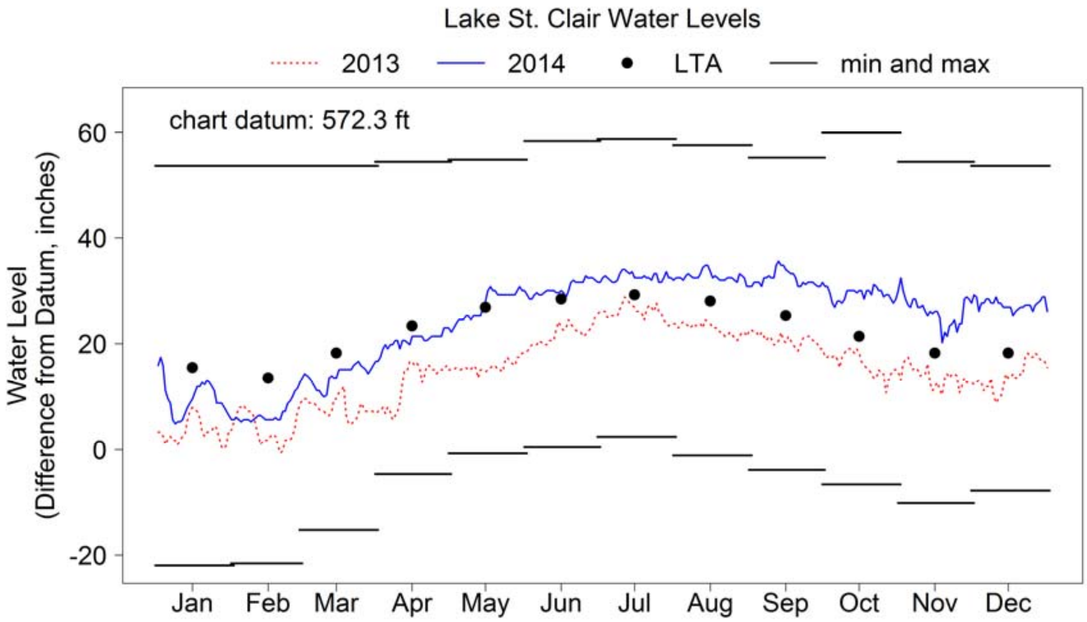

Figure 5: Lake St. Clair Water Levels

Lake Erie

Figure 6 shows the Lake Erie water levels relative to the chart datum of 569.2 ft. Following low water levels during 2012, Lake Erie levels recovered to normal conditions by the end of 2013 and remained at or slightly below average levels until April of 2014. Since May 2014, water levels have been above their long term average monthly levels. The seasonal rise resulted in water levels increasing by about 18 inches from February to July 2014. By December 2014 Lake Erie water levels were 9 inches higher than December 2013 and 7 inches above LTA.

Precipitation was greater than average from April 2014 to September 2014, resulting in higher than average NBS, as shown in Figure 7. Large April and May NBS values in 2014 are a result of the combined impacts of above average precipitation during those months and increased runoff resulting from snow accumulation during the colder and wetter than average early winter months.

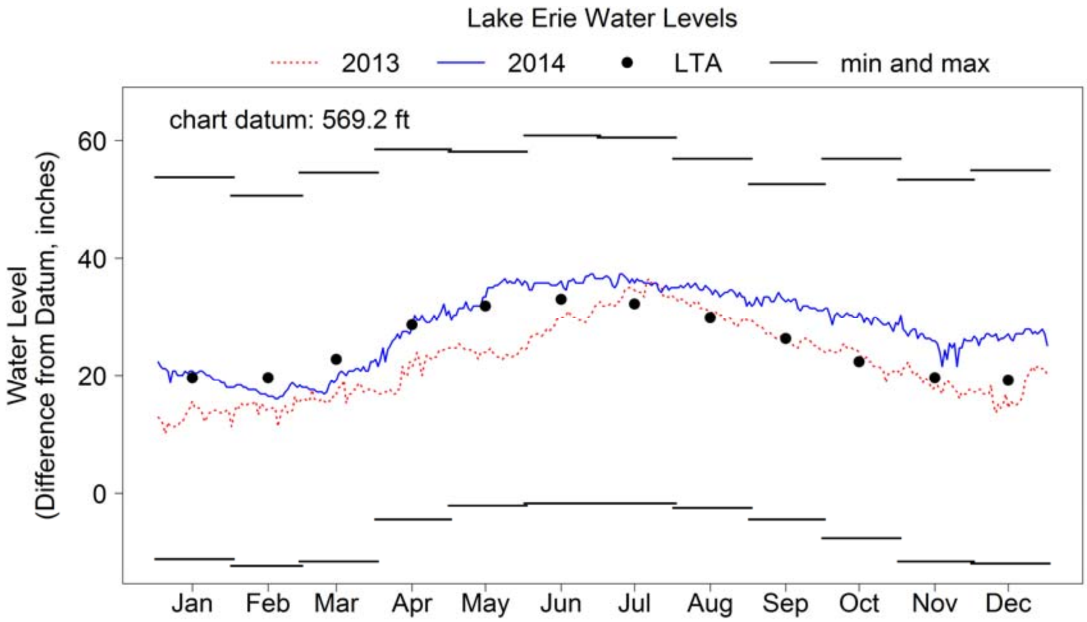

Figure 6: Lake Erie Water Levels

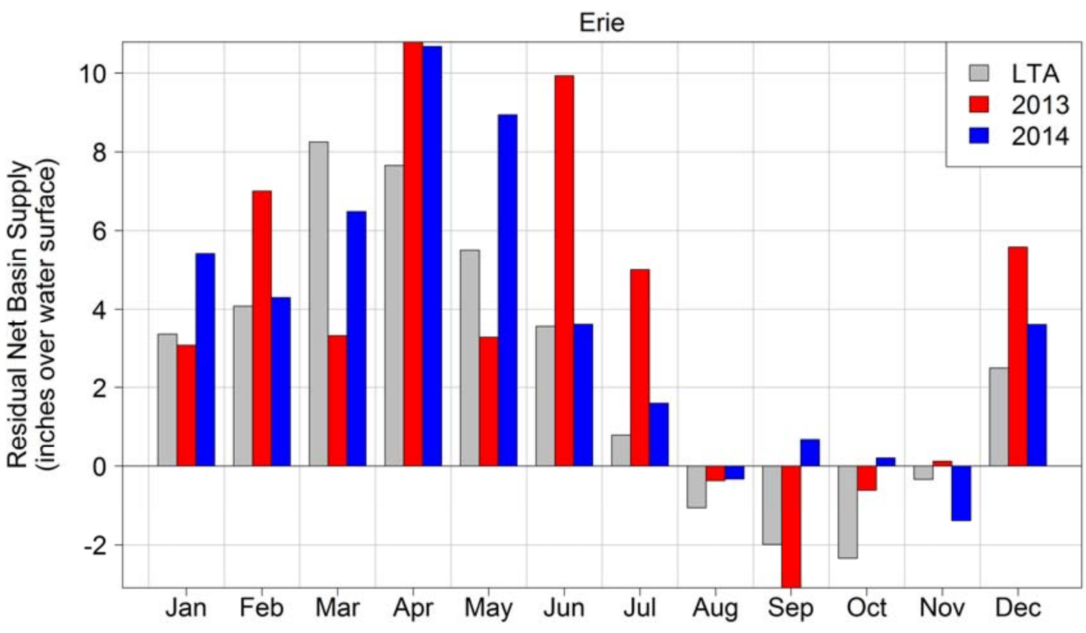

Figure 7: Lake Erie Residual Net Basin Supply

Lake Ontario

Figure 8 shows Lake Ontario water levels relative to the chart datum of 243.3 ft. Lake Ontario is the only Great Lake whose water levels began January 2015 lower than January 2014. During 2014, the Lake Ontario monthly mean water levels remained 5 inches below to 5 inches above LTA.

Figure 9 shows the 2014, 2013 and LTA NBS for Lake Ontario. Below average NBS in February and March of 2014 followed by well above average NBS in April resulted in a rise of about 13 inches from March to May. Higher than average NBS persisted from April to August due to monthly precipitation that was from 7 to 47% above LTA, and this corresponds to a period of higher than average water levels. Precipitation was 70% and 56% of LTA during the months of November and December, respectively, however, bringing water levels back below LTA. Lake Ontario ended the year at 2 inches below LTA.

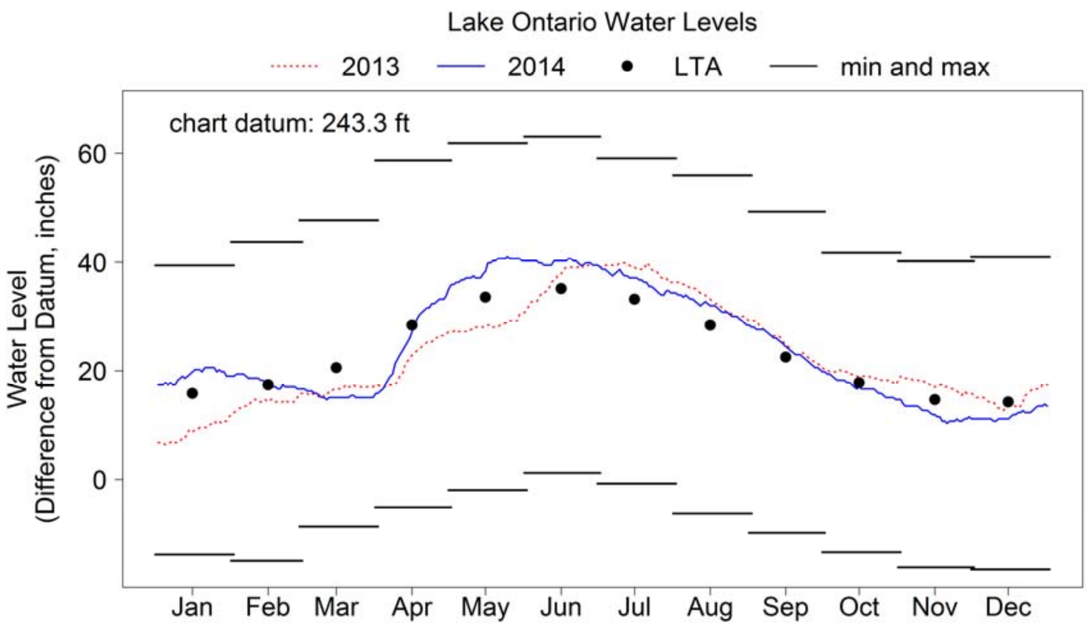

Figure 8: Lake Ontario Water Levels

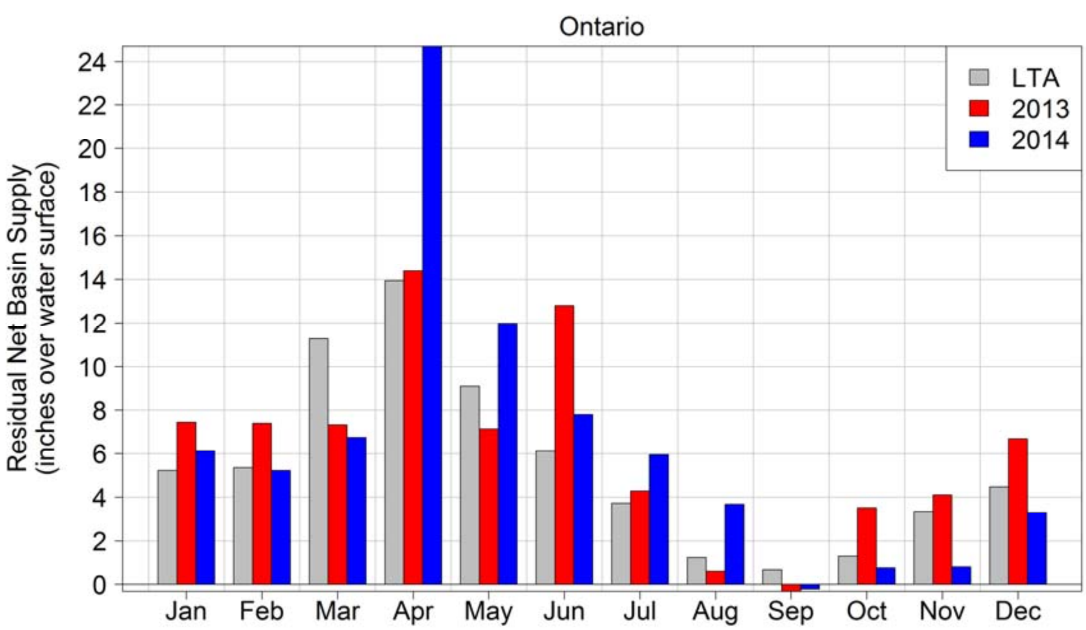

Figure 9: Lake Ontario Residual Net Basin Supply

Winter Conditions of 2013-2014

During the winter of 2013-2014, the Great Lakes basin experienced very cold temperatures and record setting snowfall. The December to February season in the Great Lakes region was the coldest winter in 20 years. The amount of water contained in the snowpack was 125% to 300% of average, resulting in very large spring runoff to the lakes. The increased runoff was the primary cause of extremely high seasonal rise seen especially on the upper lakes.

Ice cover began early in the season and reached the second highest percentage since 1973 (Figure 10). Maximum ice coverage (92.5%) occurred on March 6, 2014. Winters with high ice cover are often followed by cooler summer water temperatures and lower evaporation rates, but high evaporation rates can occur during the autumn and early winter preceding high ice periods.

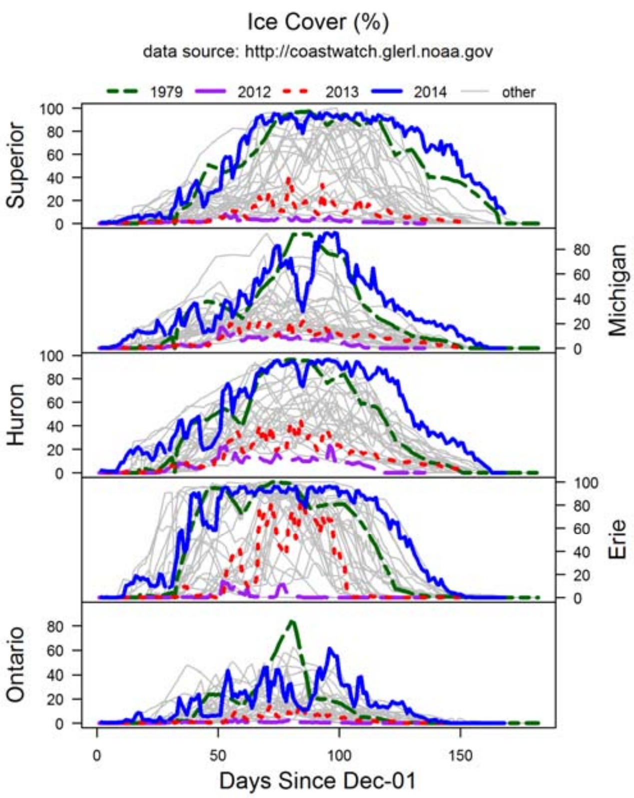

Figure 10: Ice cover for years 1973 to 2014.

More Information

Update articles are included in the February and August *Monthly Bulletins* highlighting topics and explanations relevant to Great Lakes water levels. February's *Monthly Bulletin* will typically include an annual summary from the year before and each August *Monthly Bulletin* will typically include a summary of the first six months of the year.

The *Monthly Bulletin* is sent by postal mail. To be added to the postal mailing list, please send an email to hhpm@usace.army.mil or call 1-888-694-8313 and select option 1. Alternatively, the Monthly Bulletin can be viewed on our website. The home page is: http://www.lre.usace.army.mil. In addition to the *Monthly Bulletin*, the Detroit District issues the *Weekly Great Lakes Water Level Update* and the *Weekly Great Lakes Connecting Channels Water Levels and Depths*. Both products are updated each Thursday and can be located here:

http://www.lre.usace.army.mil/Missions/GreatLakesInformation/GreatLakesWaterLevels/WaterLevelForecast.aspx

The Detroit District also has a Facebook page which can be found here:

https://www.facebook.com/pages/Detroit-District-US-Army-Corps-of-Engineers/144354390916

The Detroit District welcomes comments on all of our forecast products. Please email questions and comments to hhpm@usace.army.mil. To contact the District by phone call toll free 1-888-694-8313 and select option 1. The Detroit District's mailing address is:

Department of the Army
Detroit District Corps of Engineers
ATTN: CELRE-HH-W
477 Michigan Avenue
Detroit, MI 48226